August 2007 Status Report to the Provost: Subsurface Biosphere Education and Research Initiative (Lewis Semprini (COE); Dan Arp (COA,COS); Peter Bottomley (COA,COS); Marty Fisk (COAS); Dave Myrold (COA)

Summary of Achievements

The SBI program has made significant progress towards its ultimate goal of creating a Center of Excellence in Subsurface Biosphere Education and Research. The SBI supported three extremely talented faculty members in the colleges of Agricultural Sciences, Ocean and Atmospheric Sciences, and Engineering. These faculty members have brought new expertise in geomicrobiology (Rick Colwell, Professor, COAS), transport and physical processes in the subsurface (Dorthe Wildenschild, Environmental Engineering, COE), and organic biochemistry (Marcus Kleber, Crop and Soil Science, COA). During 2006-2007, the request of the Provost Office we kept our spending at 300K, which was mainly used to support the start-up of the new SBI hires. We were also able to maintain all of our other activities including the Website and Newsletter, support of our Annual Workshop, and Undergraduate Summer Internship Program.

Dr. Colwell is an internationally known expert in geomicrobiology, and brings much needed expertise to COAS and the SBI on subsurface microbiology. He has brought $180K of research funding to OSU, along with a long track history of successful research from different DOE programs. He has been involved with preparing over $1.5 M in grant proposals since starting at OSU.

Dr Wildenschild is developing an international reputation in studies of flow and transport in porous media. Dorthe is currently the PI on two grants totaling 482K from the NSF Hydrology Program, and a Co-PI on a recently funded 421K NSF grant. She submitted an NSF Career Proposal ($399K) this past summer and has collaborated on over $1.0M in proposed research with other OSU faculty. She is advising several Ph.D. students and is serving as a research mentor of several SBI summer undergraduate interns. Last year she taught three classes for the Environmental Engineering Program. She is also collaborating with numerous faculty outside of OSU and research scientists at several national laboratories.

Dr. Kleber joined the OSU Department of Crop and Soil Science in the Fall 2006. As a PI he submitted a 796K proposal to NSF and as a Co-PI submitted several proposals with other OSU faculty, totaling over 1.4M in funding. These proposals are still pending awards. He delivered a new graduate course CSS 525X Mineral Organic Matter, and will offer an undergraduate course next year. He is collaborating with investigators at the Lawrence Berkeley National Laboratory.

The SBI website continues to develop, and provides information on the many activities of the SBI, including funding opportunities, seminar announcements, and internships. It currently serves 1200 visitors a month, which is up from 750 visitors, last year. Over the past year we published 10 monthly newsletters and 8 feature research articles on a subsurface biosphere topic of interest.

Our summer internship program for undergraduate students was open for the third year and supported 7 undergraduate internships, which as down from 11 supported in the previous year. The internships will culminate with a student poster presentation in September.

The SBI workshop in June brought together 50 OSU faculty and students and showcased SBI research and the Earth's Subsurface Biosphere Research IGERT Program. The workshop included talks from three internationally known researchers from national laboratories and universities across the United States, and several OSU faculty members and graduate students. A poster session allowed over 20 graduate students to share their research.

We supported the writing of a preproposal to NSF for the renewal of the Earths Subsurface Biosphere IGERT grant, which was successful, and we are in the process of writing the full proposal. The SBI is providing leveraging support for the IGERT grant proposal. Table 1 provides a summary of our metrics of success for 2006-2007 and goals for 2007-2008. We have been successful in meeting most of our goals, and have exceeded them in several cases. These will be now discussed in detail.

SBI Faculty Hires

The SBI Program participated in the hiring of three new faculty members in 2005-2006. The faculty positions are spread across three colleges: COA, COAS, and COE. These three hires havel provided a broad range of

Table 1: Summary of Metrics of Success of SBI

	Goal (2006-2007)	Actual (2006-2007)	Goal (2007-2008)
Faculty Hires	**One Hire**	**No Hires**	**One Hire**
Courses Taught by Three SBI Faculty Hires	**Two Courses**	**Five Courses**	**Seven Courses**
Proposals Funds Submitted by SBI Hires as PIs	**$1.5M**	**$2.0 M**	**$2.5M**
Proposals Funds Submitted by SBI Hires as CO-PIs	**$2.0M**	**$3.0M**	**4.0M**
Grants Funds awarded to SBI Hires as PI	**$500K**	**$550K**	**$1.0M**
Grants Funds awarded to SBI Hires as Co-PIs	**500K**	**570K**	**$1.0M**
Graduate Students Advised by SBI Hires	**2**	**5**	**8**
Book Chapters and Journal Articles by SBI Hires	**9**	**17**	**12**
Large Interdisciplinary Grant Proposals Supported by the SBI	**$3.5 M**	**$2.2M**	**$5.0M**
Summer Undergraduate Internships	**15**	**7**	**15**
Past Summer Interns Entering OSU Graduate School	**2**	**1**	**2**
Workshop Attendance	**50**	**50**	**60**
Invited Speakers	**8**	**5**	**14**
Website (visits/month)	**1500**	**1200**	**1500**
Newsletter	**Monthly**	**Monthly**	**Monthly**
Ph.D. Enhancement Grants	**5**	**0**	**5**
Ph.D. Graduate Fellowships			**5**

expertise needed for the creation of a Center of Excellence for Research and Education in the Subsurface Biosphere. These include subsurface microbiology, subsurface transport and physical processes, and subsurface organic and biochemistry. The SBI has obligated a total of $500K in funds over the next two years for salary and start-up packages for these faculty hires, of which 255K was spent in 2006-2007 (Table 2).

Dr. Rick Colwell joined COAS in June 2006 as a professor of marine geology and geophysics. Dr. Colwell research expenditures totaled $160K over the past year. He currently has over 370 K in research funding at OSU, and is Co-PI on another 150 K of research. His research includes several DOE-funded projects such as: Coupled Biogeochemical Process Evaluation for Conceptualizing Trichloroethylene Co-metabolism and Realistic Rates for In Situ Biogenic Methane Production in Gas Hydrates *(*research on the microbiology of subsurface methane hydrates). His present research interests are focused on physical and chemical controls on the distribution of microbes in key subsurface environments (e.g., where high levels of methane are generated in marine sediments or where microbes are essential for the natural attenuation/ bioremediation of contaminants in the subsurface). Dr. Colwell has been involved with the development of over $2.0 M in research

proposals since arriving at OSU, and is already collaborating with researchers in COAS, COE, as well as several DOE laboratories. He is currently advising two Ph.D students and is mentoring an REU student. He has published two book chapters and seven journal articles since arriving at OSU. He has given a number of invited talks, several to the NSF review panel for the developing and Deep Underground Science and Engineering Laboratory. He is currently working with several National Laboratories INL, LBNL, and PNNL, and numerous researchers at these labs, the Integrated Ocean Drilling Program, and the Council of Canadian Academics. He is currently doing collaborative research with seven OSU faculty. Last year he led OC 669 (the IGERT Team Synthesis Course) and is developing OC 399H (Astrobiology Course) for the Honors College. During 2006-2007, Rick has spent 31K of his 50K of SBI start-up funds.

Dr. Dorthe Wildenschild started her position as assistant professor of environmental engineering (COE) in July 2006. The SBI has committing $150K in funds to support this position. Dr. Wildenschild specializes in subsurface (porous media) characterization in terms of physical, chemical, and biological processes; her research focuses on describing physical processes occurring in subsurface porous media. In 2006-2007, Dorthe taught three courses in the Environmental Engineering: ENVE 322 Fundamentals of Environmental Engineering; ENVE 456/556 Sustainable Water resource Development; and CE518 Groundwater Modeling. She is planning on developing two graduate level classes that will be of interest to the SBI program: Environmental and Biological Imaging Techniques and Applied Environmental Modeling.

Dr. Wildenschild's is the PI of two grants totaling 482K from the NSF Hydrology Program, entitled: 1) Experimental and Numerical Characterization of Thin Films in Three-Dimensional Porous Media; 2) Interfacial dynamics in multi-phase flow and transport processes. She is a Co-PI, with three other OSU faculty on a recently awarded 421K grant from NSF entitled: Mathematical and Experimental Analysis of Reactive Transport in Discontinuous Porous Media.

This summer she submitted an NSF CAREER Proposal for $399K entitled: Pore-scale visualization and quantification of the processes controlling non-aqueous phase liquid dissolution in groundwater. She is Co-PI on a pending DOE 929K proposal with OSU colleagues entitled: Bioimmobilization of uranium by microbiallymediated coprecipitation. She is also collaborating with over 10 scientists and engineers at several universities and national laboratories around the United States. She is working with scientists at the Lawrence Berkeley National Laboratory on new imaging methods called phase contrast tomography using state of the art facilities at the laboratory. Dorthe is a co-author on a publication that is in press and has given numerous presentations national and international conferences. She was an invited speaker at the Gordon Research Conference on Flow and Transport in Porous Media this summer. Dr. Wildenschild is active in providing high school students and undergraduates with research experiences, and has had several NSF-funded REU, and has mentored two SBI summer interns over the past summer. She was featured

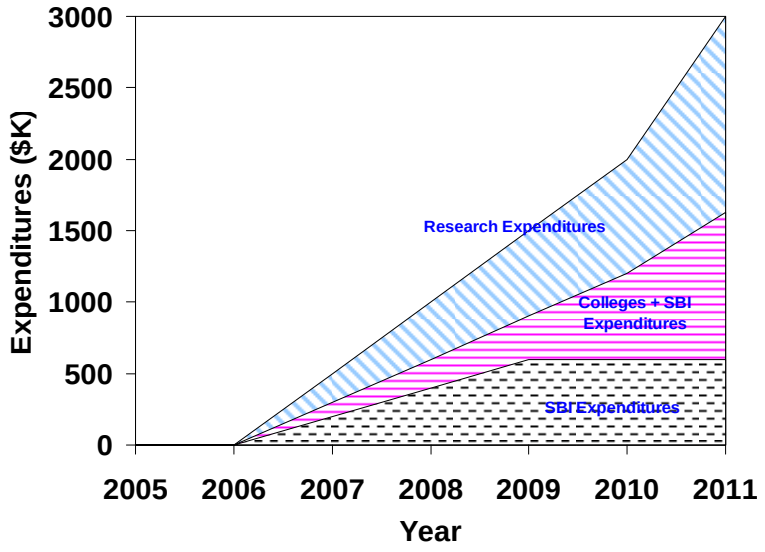

Figure 1. Expenditures of the SBI and Colleges on the three faculty hires and expected increase in Research Expenditures of the new hires.

in an OSU this Week Article about the SBI Program, and is part of a Terra article for the Summer of 2007: http://oregonstate.edu/terra/departments/earth/glass-half-full.html. During 2006-2007, Dorthe spent 85K of her 150 K of SBI start-up funds.

Dr. Markus Kleber, a soil organic biogeochemist joined the Department of Crop and Soil Science in November 2006 as an assistant professor. The SBI has committed $300K in funding to support the start-up costs and initial salary for this position. Dr. Kleber is an expert in organic matter-mineral interaction, and fills a very important area in both teaching and research for the SBI. Since joining OSU he has developed and taught a new course CSS 525X Mineral Organic Matter Interactions and is planning to offer an Undergraduate course, Basic Soil Ecodynamics in the Winter of 2007/2008. Markus and been very active in writing research proposals and collaborating with OSU faculty since starting his position. He is the PI on a 796K proposal, which is pending at NSF, entitled "Soils as biogeochemical Si sources: Linking processes of Si cycling to export fluxes from soil systems (Co-PI's: Maria Dragila, John Baham, Hero Gollany). He has been Co-PI on several other proposals submissions to the USDA, NSF requesting over 1,400K in funding. The proposals cover a broad range of topics including: 1) Fate of Fullerenes in Subsurface Environments: Quantifying Partitioning to Natural Particulate Matter and Dissolved Organic Matter**;** 2) Quantifying Cycling and Release of Fe and Si in an Isochronic and IsotropicSoil Landscape; How will changes in temperate forest detritus production alter soil organic matter dynamics and carbon storage? The proposals involve collaborations with 8 different faculty members at OSU and 9 research scientists or faculty members outside of OSU. He continues to have strong research ties to the Lawrence Berkeley National Laboratory, and is using facilities, such as their Advanced Light Source Beamline for his research. Marcus has been extremely active in publishing his research. Since arriving at OSU he has published two book chapters, and has been the Co-author on 5 peer reviewed journal publications. As part of his outreach activities he has mentored a SBI Undergraduate Intern this summer. Marcus spent 83K in SBI funds in 2006-2007 and is planning to spend 133K in funds in 2007-2008.

Shown in Figure 1 are the expenditures of the SBI on the three faculty hires, the combined expenses of the colleges and the SBI, and the expected research expenditures by the new faculty hires on research grants and contracts. The SBI will invest $500K over a three year period on the new hires. The colleges will invest about 1000K over five years. We expect that each new hires will expend about $200K/year in research, which will total about 3,000K over a five year period. The SBI new hires are on track with developing 200K in annual research expenditures. Thus the 500K investment by the SBI can result in $4,000K of expenditures by the colleges and on research by the new hires.

As shown in Table the SBI have been very active in proposal submissions and developing collaborative research, as indicated by the proposal submissions that they are Co-PIs. They have also been very active in publishing book chapters and peer reviewed journal articles, with over 17 published or in press.

Proposal Submissions

The SBI is supporting the generation of a renewal the Oregon State University-Portland State University IGERT–The Earth's Subsurface Biosphere: Linking Microbial, Geophysical, and Geochemical Processes (http://oregonstate.edu/dept/igert) and have expanded it to include faculty and students at the University of Oregon and the Oregon Health & Science University. A Preproposal entitled – Dynamic Processes in Multiphase Subsurface Ecosystems IGERT: Systems at Interfaces was submitted to NSF and received excellent reviews, and a request by NSF for a full proposal. If the renewal is successful, the IGERT, will potentially involve 26 faculty at OSU, 5 at PSU, 4 at the University of Oregon, and 4 at the Oregon Health & Science University. The goal of this IGERT, 'to inspire and train the next generation of "subsurface scientists", supplying them with the depth and breadth of experience required to understand and predict the complex behavior of subsurface ecosystems,' fits in very well with the mission of the SBI and will help provide for long term support in the continued development of the Center of Excellence. If funded, it will also provide an

opportunity for collaboration of subsurface biosphere research among four universities in the OUS system. The SBI will provide leveraging support to the IGERT Proposal, including support of a seminar series, an Annual SBI/IGERT Workshop, and support of Undergraduate Summer Internship Program, with IGERT graduate students serving as mentors.

Summer Workshop

The SBI, along with the NSF-funded Earth's Subsurface Biosphere IGERT Program, sponsored a scientific workshop at the Hallmark Resort in Newport, OR, June 17 -19, 2007. The workshop included platform presentations by three internationally known researchers: Mary Firestone (UC Berkeley); Peter Nico (Lawrence Berkeley National Laboratory); and Tommy Phelps (Oak Ridge National Laboratory) as well as the new SBI faculty hires (Dorthe Wildenschild and Marcus Kleber) and the six IGERT graduate students. The poster session permitted graduate students to present results of their research, with 22 posters presented. The Workshop covered r the broad range of topics associated with the SBI from Molecular Microbial Ecology to Microbial Fuel Cells from Marine Sediment. The abstract proceedings from the workshop can be found on the SBI website http://sbi.oregonstate.edu/research/su07workshop/07SBI_booklet.pdf
The participants also discussed research collaborations that can be supported by the SBI, the renewal of the IGERT grant and the continuation of the Annual Workshop with support of the SBI Program.

SBI Website, Feature Stories, and Newsletter

This past year we continued the development of the Website, the creation of Feature Stories and the Newsletter, to enhance communication among OSU faculty and staff with interest in the subsurface biosphere. The Website now receives about 1200 visits per month, and is top return for a Google search on the keywords "Subsurface Biosphere." Most visitors are from U.S. educational institutions, but also include commercial, network, and international domains. The most popular pages are the science background page and the research feature stories. Over the past year our research feature stories focused on the research of the new SBI faculty hires and the research of the Earths Subsurface Biosphere IGERT graduate students that were completing their Ph.D. degrees. These several-page articles are written for an interdisciplinary audience and provide a way to highlight and share OSU research activities. SBI research features can be found on our Website: http://sbi.oregonstate.edu/news/features.htm. An example of the most recent Research Feature is the research of Stephanie Boyle 'Nitrogen cycling and microbial communities in forest soils' http://sbi.oregonstate.edu/news/200706.htm.

Summer Internships

The SBI program is completing its third summer internship program for undergraduate students. The goal of these internships is to provide undergraduates at Oregon State University with rewarding research experiences that will stimulate their interest in the subsurface biosphere and encourage them to pursue graduate studies. The program focuses on, but is not limited to, under-represented minority and women students. The number of OSU undergraduate students decrease from to eleven in 2006 to seven in 2007. We are evaluating the reason for this decrease and will focus on increasing the internships next year. The interns will present the result of their summer research in a poster session to be held in early September.

Goals for 2007-2008

All SBI activities will be continued into 2007-2008, including support of the workshop, website, newsletter, and the internship program. We will continue to promote the hiring of an additional faculty member, potentially in the area of rhizosphere microbiology. We continue to be limited in the hiring of new faculty, due to budget constraints at the College level. Cuts, for example, in the Engineering ETIC funding proposal resulted in a loss of a potential SBI faculty hire in engineering. The SBI will work with the three new hires to develop collaborations for them at OSU.

Part of this development will be through an informal seminar series. We expect their contributions to teaching and research to continue to increase over the next year. Several new courses will be delivered to support the SBI program. We will support the renewal of the Earth's Subsurface Biosphere IGERT grant and will provide leverage of funds for that proposal.

We will continue to offer the summer internship program and plan to increase the number of a summer interns that apply and choose OSU for graduate school. We also plan to increase our workshop attendance to include others from the OUS system and national. We also plan to initiate enhancement grants for senior Ph.D. students performing subsurface biosphere research. These grants will permit research into exploratory areas that will provide the basis for additional publications or information needed for faculty research proposals. We also plan to offer stipend enhancement grant to help attract students applying to graduate school that have an interest on subsurface Biosphere research.

Budget

At the start of the 2007-2008 period we have 570 K of funds remaining of the 900K of funds that have been committed thus far by the university. The total SBI funds spent thus far in 2006-2007 is 292 K, with another 33 K of spending expected by Sept 15th, resulting in a total of 325 K. 48 K in SBI funds was spent prior to 2006-2007. At the request of the Provost we kept our spending for 2006-2007 at around 300K, equal to the funds we received for that year, and did not spend funds that had accumulated from the previous years. We have allotted 500K in start-up and salary for our three new faculty hires. A total of 255 K in start-up funds has been used thus far for this purpose. Table 2 presents a breakdown of how these funds were spent in 2006-2007. The projected spending for 2007-2008 is also presented in Table 2. The significant increase in spending will result from the continued support for the new faculty hires and existing programs, as well as new activites. We will also expand several of the programs that have been established including the initiation a research grant program of senior Ph.D. students and graduate fellowships for incoming students.

	2006-2007	**Projected 2008-2009**
	(K)	**(K)**
Administration	**12**	**25**
Summer Internships	**20**	**40**
Website; Newsletters	**8**	**20**
Workshop/Seminars	**25**	**35**
Proposal Generation	**5**	**5**
SBI Faculty Hires	**255**	**245**
Visiting Faculty	**0**	**4**
Ph.D. Research Grants		**50**
Ph.D. Graduate Fellowships		**40**
Total Expenditures	**$325K**	**$464K**